

Design and Development of Electro Hydraulics Hitch Control for Agricultural Tractor

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ABSTRACT

Tractor hitch control system is used for attaching and operating various Agricultural Implements and for operating tipping trailer. The system has also got provision to attach additional Aux valves for rear and front mounted attachments. The rear mounted implements are coupled to the tractor using Three Point Linkage (3PL) System. The hitch hydraulics system consists of hydraulic pump, filter, piping's, fittings and hydraulics lift unit. Hydraulics lift unit consists of a proportional control valve, cylinder, piston and power linkages. Conventional control valve is hydro mechanical part operated by mechanical linkages. The control valve and linkages plays major role in performance of hydraulics system. Hydraulics is required to operate in extreme conditions of soils such as very soft like sand to very hard like black cotton sand. These two extreme conditions makes linkage and control valve optimization work very challenging and very difficult to get single solution for soft and hard conditions. In addition to best performance requirements, lesser power loss and operating effort are also important for customer satisfaction. To meet this challenge of high on performance in all soil conditions, effortless operation, high on efficiency (less hydraulics power loss) and aesthetics, Electro Hydraulics Hitch is the best solution.

In the present work, Electro Hydraulics Hitch System is designed and developed for Agricultural Tractor to replace conventional hydro mechanical hitch. This system consists of specially made control valve manifold using Solenoid Valves, Hydraulic Control Unit (HCU), Position Sensor, Draft Sensor (Load Cell) and input levers with sensors. They are connected by using suitable wiring harness. The system is having all features functions i.e. Position Control (PC), Draft Control (DC) and Quick Lift (QL) of conventional system. The basic common valves like, Pressure Relief Valve (PRV), Check Valve (CV), Shock Load relief Valve (SLRV), Isolator valve and Tipping trailer port are adopted from current design. The customer touch points are maintained same as that of conventional type i.e. PC, DC levers and QL button.

The work also includes analysis and optimization using Simulink Matlab, performance tests in lab and fields for proving in various soil conditions.

KEYWORDS: Hitch Control System, 3 Point Linkages, Electro Hydraulics, Position Control, Draft Control, Quick Lift. Hydro Mechanical System. Design Validation Plan, Hitch Regulation, Sensitivity, Accuracy

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INTRODUCTION

Tractors are used for various Agricultural and non-Agricultural applications. The Agricultural applications includes primary and secondary applications for land preparations, intercultural applications for crop management work and for harvest and post-harvest works. Non-Agricultural applications includes Haulage, Loaders, Dozes and Backhoes. All the equipment's for these applications are controlled using tractor hydraulics system. Hydraulics system used to control rear mounted Agricultural Implements is called Hitch Control System. As hitch control system in medium of power transfer from tractor to implement application, the performance of hitch control becomes utmost importance for best performance of tractor implement combination.



Fig.1. Tractor with Implement

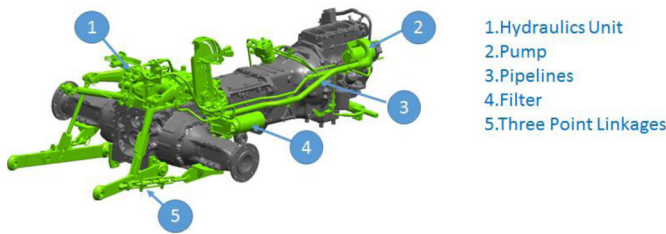


Fig. 2. Tractor Hydraulics Parts

Fig. 1. shows implement attached to tractor using hydraulics three point linkages and Fig. 2, gives various major parts of tractor hydraulics. Among all Hydraulics Unit (1) is main subsystem with controls the hitch function. Hydraulics unit have two basic modes of controls for implement namely Position Control (PC) and Draft Control (DC). Additional third control is also introduced now days called Quick Lift (QL).

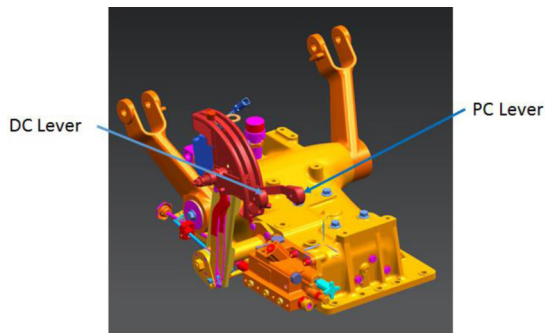


Fig. 3. PC DC Control Levers

In PC mode, set position of implement with respect to tractor is controlled (in and outside ground). In DC the load on implement (Draft) is controlled to maintained set depth of operation. The conventional PC and DC mechanism working is explained in following paragraphs;

POSITION CONTROL MECHANISM (PC)

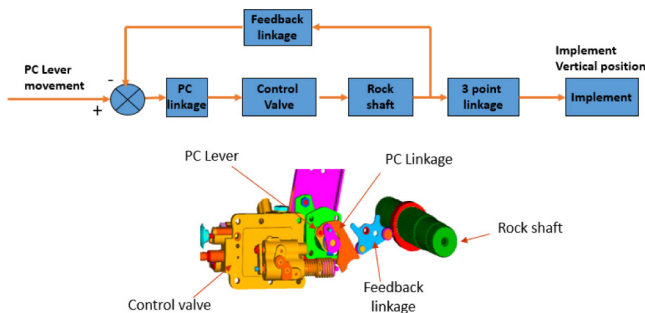


Fig. 4. PC Mechanism

PC lever is used to set the position of implement, lever motion is transferred to Control Valve through PC linkages. Control valve diverts the fluid to Cylinder and Piston which is connected to Rockshaft. Rockshaft lifts the implement. Once the desired position of shaft is achieved feedback linkages gives feedback signal to

Control Valve to stop the flow to Cylinder and implement is held in set position. Oil flow from Pump is diverted to reservoir at low pressure. The implement works at set position irrespective of resistance loads exerted on it.

DRAFT CONTROL MECHANISM (DC)

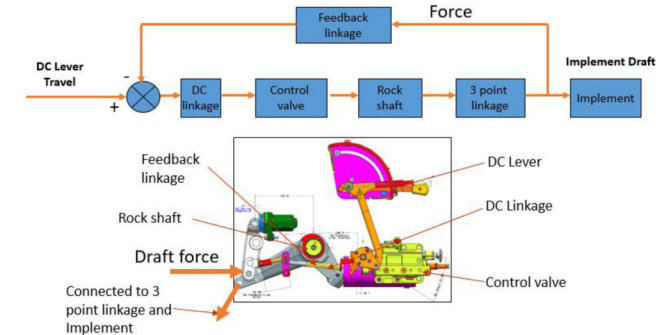


Fig. 5. DC Mechanism

DC lever is used to set Draft (resistance on implement). DC lever motion is transferred to Control Valve through DC linkages. Control valve diverts the fluid to Cylinder and Piston which is connected to Rockshaft. Rockshaft controls the implement. Once the set Draft load is reached feedback linkages gives signal to Control Valve to stop the flow to Cylinder. If the Draft Load is less than set valve implement is lowered in ground to achieve set value. The system works in close loop to reduce error and tries to maintain Draft close to set value. In DC mode depth of implement is varied based on Draft force error. To convert Draft load of implement into feedback signal Draft Sensing Mechanism is used. Top link is used to sense the draft force. Typically coil spring is used as sensor in tractors <100 hp, where as other types of springs like, torsion bar and leaf spring are also used.

CHALLENGES IN HYDRO-MECHANICAL SYSTEM

As mechanization is growing at faster rate due to its various benefits, it is recognized by customers. Tractors are being used for various applications ranging from light soils to very hard black cotton soil. The light soil applications call for precision control of implements like leveling, seeding and potato cultivation. Hard soil applications like ploughing and cultivations call for heavy duty designs with higher capacities. Some important requirements of PC and DC are as below;

PC Requirements

Precise control of PC lever, High accuracy, less operating effort, lesser cycle times for higher productivity.

DC Requirements

It should be capable to sense light as well as heavy loads, to have less hysteresis losses, precise control of lever, less operating effort. Better control of DC will result to less tire slippage and reduced fuel consumption.